OBSERVATIONS ON THE REPRODUCTION AND ASSOCIATED PHENOMENA IN THE MALE FRUIT BAT, *CYNOPTERUS SPHINX* (VAHL) IN CENTRAL INDIA[1]

SATWANT SANDHU[2]

(*With four text-figures*)

Males of *Cynopterus sphinx* in Central India experience two periods of sexual activity, once during September-October and a second time during February-March with a short period of regression during November-December and a longer sexually quiescent period between March and September. The regressed adult testis may weigh less than the testis of the animals approaching their first sexual season. Animals born during June-July experience their first sexual season at the age of 15 to 16 months whereas those born in February-March experience their first sexual season at the age of 19 to 20 months. Sexual maturity or otherwise cannot be determined on the basis of the body weight of the animals.

INTRODUCTION

A study of the breeding biology of bats is of special interest since these animals exhibit a wide range of reproductive adaptations. The protracted survival and viability of inseminated spermatozoa in the female genital tract of several species of bats inhabiting cold and temperate climates (Rollinat and Trouessart 1895-1897, Guthrie 1933, Matthews 1937, Wimsatt 1942, 1944) and the occurrence of delayed implantation (Mutere 1967, Gopalakrishna and Ramakrishna 1977) and the retarded development of the blastocyst (Ramakrishna and Rao 1977, Richardson 1977) in some of the tropical and sub-tropical bats are some of the interesting adaptations which these animals have evolved. Although all these phenomena have been noticed in the bats, most of the studies relate only to the females, whereas the reproductive habits and associated phenomena in the male bats have received very little attention, and even the few observations, which have been made on the males, have also been made only with a view to confirming the occurrence of reproductive adaptations in the females (Courrier 1927, Pearson *et al.* 1952). Among the more than one hundred species of bats reported from India some details regarding the reproductive habits of the males are available with regard to a single species of insectivorous bat, *Scotophilus temmincki*, reported about 35 years ago by Gopalakrishna (1948, 1949). A casual reference to the protracted viability of the spermatozoa stored in the epididymis of *Hipposideros speoris* has been made by Gopalakrishna and Bhatia (1983) while studying the sex-cycle of this species. The present study on the reproductive habits of the males of *Cynopterus sphinx* (Vahl) in Central India has been undertaken not only because there is so little known about the details of the male sex-cycle of bats and specially of the tropical species, but a preliminary study (Sandhu 1982) revealed that this species exhibits two distinct reproductive cycles during the year unlike all other bats so far studied except *Rousettus leschenaulti* (Gopalakrishna and Choudhari 1977). Ramakrishna

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[1] Accepted May 1986.

[2] Department of Zoology, Institute of Science, Nagpur 440 001. *Present address*: Research Officer, Tinplate Hospital, Jamshedpur-831 003.

(1947) indicated the occurrence of post-partum oestrus in *Cynopterus sphinx sphinx* at Bangalore. Most other tropical bats have either a single cycle in the year coinciding with the cycle in the female (Baker and Baker 1936, Baker and Bird 1936, Gopalakrishna 1947, 1949, Ramaswamy 1961, Madhavan 1971) or they are sexually active throughout the year (Wimsatt and Trapido 1952, Gopalakrishna 1954, 1955). The present work is also the first detailed study on the male reproductive cycle of a megachiropteran bat.

MATERIAL AND METHODS

This report is based on the examination of the gonads and accessory reproductive structures of 279 male specimens of *Cynopterus sphinx* (Vahl) collected at random at Nagpur at frequent intervals during two consecutive years commencing from 24th January, 1982 such that every calendar month is represented by several collections. The specimens were shot with an air rifle from their roosts amidst the bunches of old hanging fronds of palm trees. Each animal was weighed with the help of a sensitive spring balance and dissected immediately. The reproductive organs and accessory reproductive structures were removed and fixed in various fixatives. The tissues were sectioned at a thickness of 7 to 8 μ after passing through graded ethanol and embedding in paraffin. The sections were stained with Harris' or Ehrlich's haematoxylin and counterstained with eosin and mounted in DPX after clearing in xylol.

OBSERVATIONS AND DISCUSSION

A. *Breeding seasons*

Figure 1 is a scatter diagram giving the weight of the right testis of the specimens collected on different dates in the year, and the curve represents the changes in the weight of the testis of adult animals during different months of the year. Microscopic examination of the testis revealed that the intensity of spermatogenetic activity was directly related to the weight of the testis. These facts indicate that in Central India the males of *Cynopterus sphinx* experience two peak seasons of spermatogenetic activity, one during September-October and the second during January-February. After the first peak of spermatogenesis the weight of the testis drops rapidly, and there is nearly complete cessation of spermatogenesis during November and December after which the testis again increases in weight rapidly during January and reaches peak values during February when there is a sudden spurt of spermatogenesis. After February there is a rapid fall in the weight of the testis reaching low values during June and July when there is no spermatogenesis and the testis has a typical regressed cytology. Since the testis is nearly completely regressed during December, the two periods of spermatogenesis in the testis should be considered as two distinct sexual seasons rather than a continuous reproductive season commencing with September and ending in the following March with a decrease in spermatogenetic activity during November and December.

Figure 2 is a scatter diagram showing the relationship between the testis weight and the body weight. The dotted lines indicate the body weight and the testis weight at sexual maturity. From the graph it is evident that the weight of the regressed adult testis falls lower than that of the testis of immature animals which are probably approaching their first sexual season.

The annual changes in the weight of the epididymis is illustrated in figure 3 from which it is evident that the epididymis also has two peaks in its weight in the year, one during

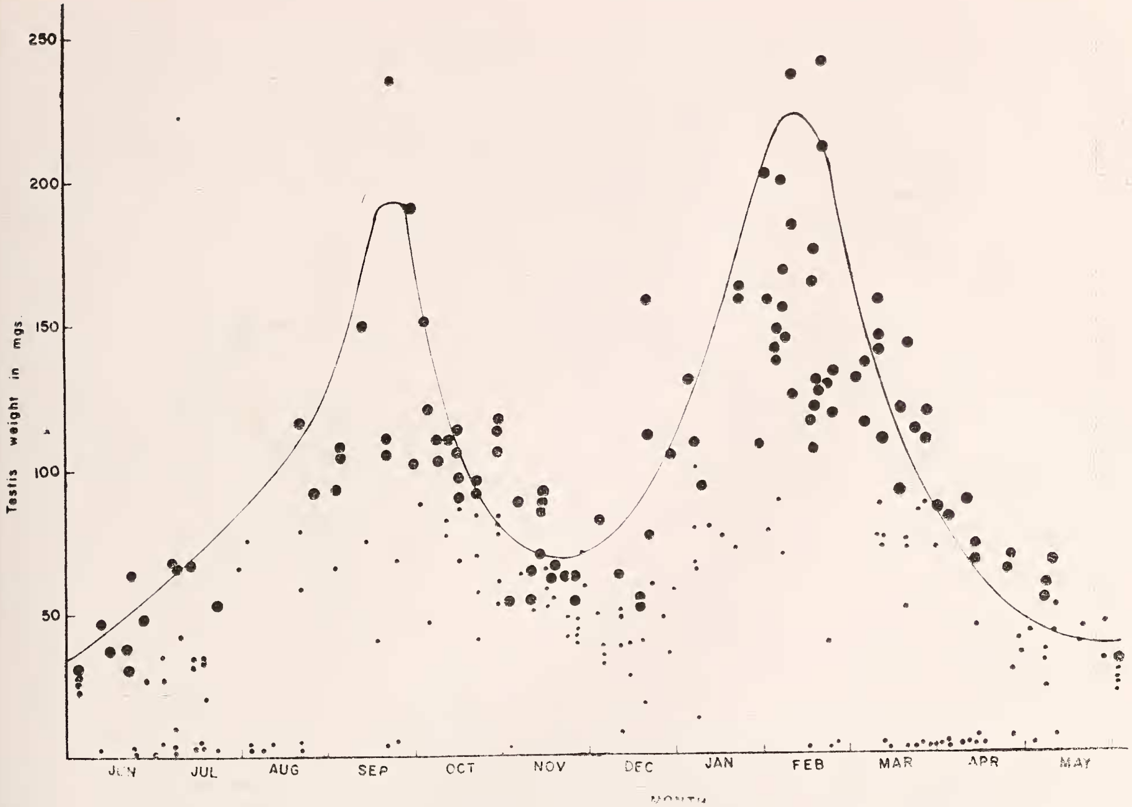

Fig. 1. Scatter diagram of the weight of the right testis of the animals plotted against the dates of collection during the different months of the year. Note two distinct peaks in the weight of the testis representing the two peaks of sexual activity. The doted line represents the lowest weight of the adult testis exhibiting active spermatogenesis.
(The heavy dots represent adult animals and the smaller dots sexually immature animals).

September-October and the second between January and March. These peaks nearly correspond to the peaks in testis weight, although the dip between the two peaks in the weight of the epididymis is not so well marked as that in the weight of the testis. Microscopic examination of the epididymis revealed that, while the epididymis was full of spermatozoa during September-October and between January and March, there is a sparse population of residual spermatozoa during December and they are totally absent from April to the beginning of September. From the above it is evident that although there is a cessation of spermatogenesis during November and December a few spermatozoa produced during September-October remain in the epididymis during November and December. This is also revealed by the graph (fig. 3) in which the first curve is considerably wider than the second thereby indicating that residual spermatozoa remain in the epididymis even after cessation of spermatogenetic activity in the testis.

The changes in the size and histology of the

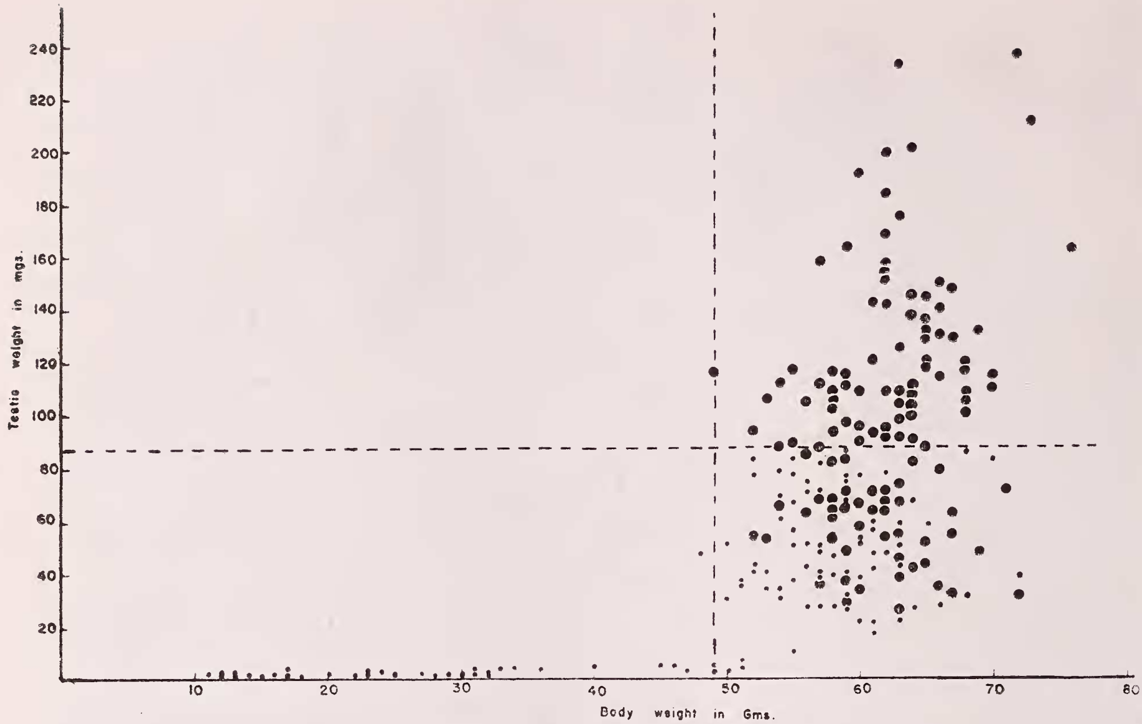

Fig. 2. Scatter diagram in which the weight of the right testis is plotted against the body weight of the corresponding animal. The dotted lines represent the lowest testis weight and the lowest weight at sexual maturity. Note that some of the inactive testes of the adults weigh less than the testes of some of the immature animals. (The heavy dots represent adult animals and the smaller dots sexually immature animals).

accessory reproductive organs in the male such as the seminal vesicles, prostate and Cowper's glands run closely parallel to those in the testis and the epididymis and these are similar to those in all other seasonally breeding mammals. These facts suggest that the males of *Cynopterus sphinx* in Central India have two distinct sexual seasons, one during September-October punctuated by a short interval of sexual quiescence during November-December and a second during January-February followed by a long period of sexual quiescence until the following September. The two periods of sexual activity in the male run closely parallel to the sexual habits of the females which experience two pregnancies in quick succession, the first pregnancy commencing in October-November with deliveries taking place during the following February-March and the second pregnancy following within a short period after parturition (Sandhu 1982).

It is evident from the foregoing account that *Cynopterus* exhibits a combination of the autumn breeding pattern of the bats inhabiting cold climates and the spring breeding habits of most of the tropical bats. *Rousettus leschenaulti* (Gopalakrishna and Choudhari 1977) is the only other bat which exhibits a similar feature. This fact, taken along with the fact that the female experiences two pregnan-

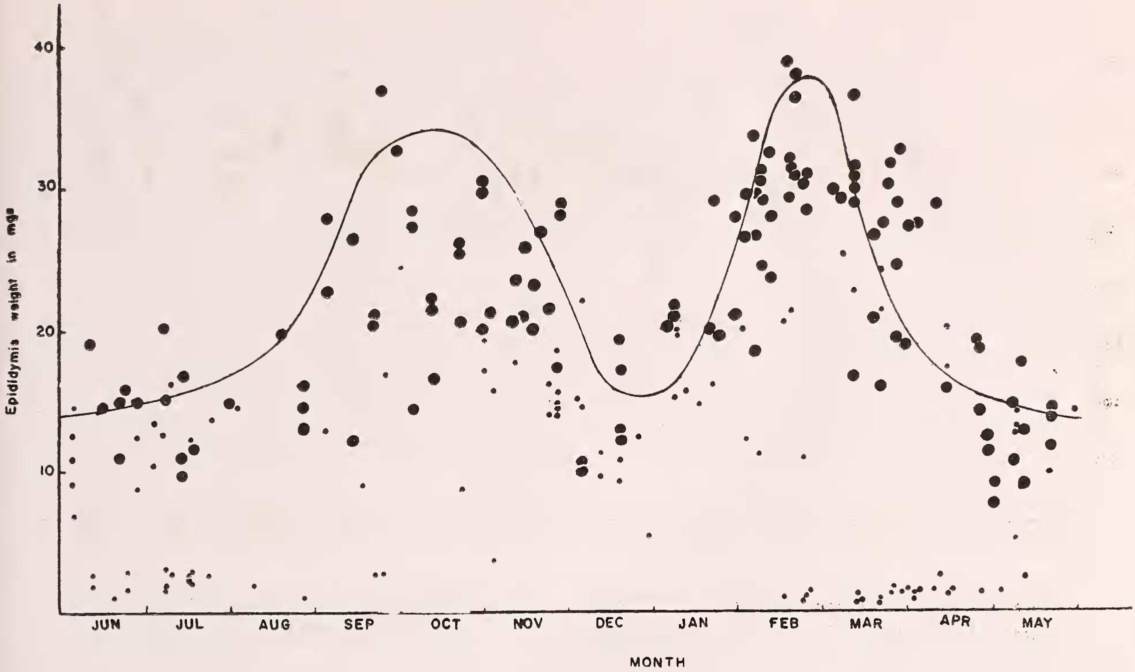

Fig. 3. Scatter diagram of the weight of the right epididymis plotted against the date of collection of the animal during different months of the year. The curve represents the two periods of peak values in the weight of the epididymis during the year. (The heavy dots represent adult animals and the smaller dots sexually immature animals).

cies in quick succession makes these two species unique among Chiroptera in regard to breeding biology.

B. *Growth and maturity*

In a previous paper it was shown that the deliveries of young ones occur twice in the year, once during February and March and the second time during June and July and that a single young one is delivered by each mother during each cycle (Sandhu 1984). Barring one exceptional specimen, which weighed 49 gm (collected on 18th February, 1982), whereas there was no sexually mature specimen with a body weight of less than 52 gm, not all specimens weighing above 52 gm were sexually mature. There were some males weighing as much as 71 gm but in which the testis presented a typically immature histology. Evidently, in these animals the body weight cannot be employed as the criterion for determining sexual maturity or otherwise in this species. However, the weight of the testis during the active breeding season is a good index of sexual maturity or otherwise in these animals. During September-October and during January-March the lowest weight of the testis exhibiting spermatogenesis was 87 mg and all the specimens with a testis weight of 87 mg and above exhibited vigorous spermatogenesis. On the basis of this criterion one could notice during the sexual season in September-October three distinct groups of animals: (1) those with a testis weight less than 10 mg — this group evidently consists

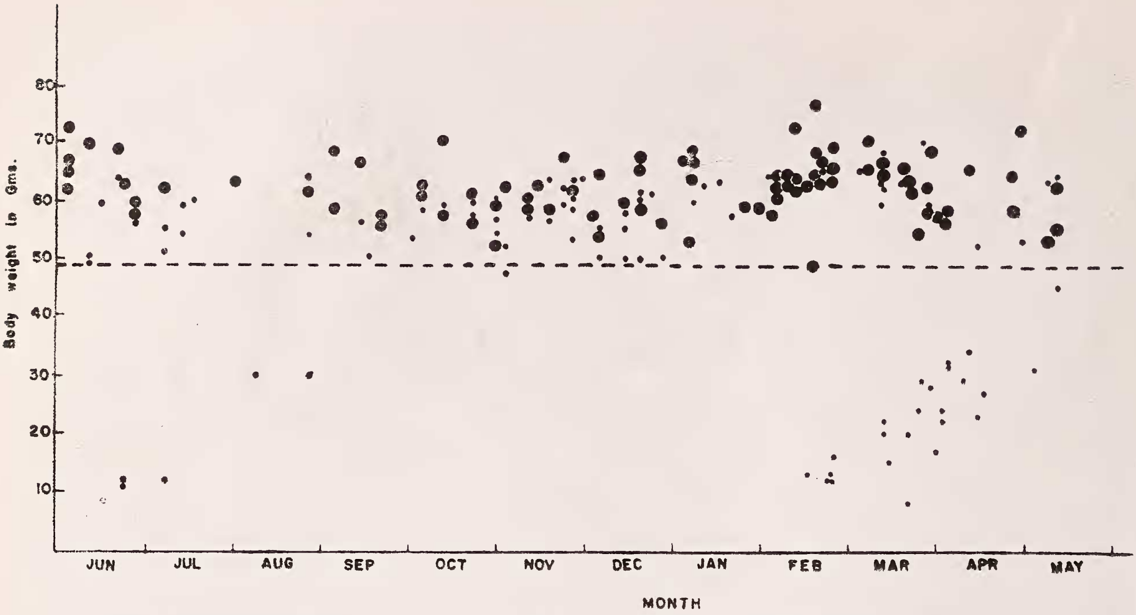

Fig. 4. Scatter diagram of the body weights of the male specimens plotted against the date of collection of the animals. The dotted line represents the lowest body weight at sexual maturity.
(The heavy dots represent adult animals and the smaller dots sexually immature animals).

of specimens born during the previous June-July, (2) specimens with testis weights between 39 and 56 mgs — this group would have been born during the previous February-March in which case they are about 7 to 8 months of age, and (3) specimens with testis weight of 87 mg and above — these animals would have been born either in June-July of the previous calendar year (that is, they are about 15 to 16 months of age) or during February-March of the previous year (that is, 19 to 20 months of age).

The specimens collected during the sexually active period during January-March also could be classified into three categories apart from those born during February-March of the same year and are mostly sucking animals: (1) animals with a testis weight of 37 mg and less — these are evidently the specimens born during June-July of the previous calendar year, (2) specimens with a testis weight between 64 and 78 mg — these would have been born during February-March of the previous calendar year and, hence, would be 12 to 13 months of age, and (3) specimens whose testis weighed 87 mg and more — there are fully sexually mature and would not have been born later than June-July two calendar years before, so that they are at least 19 to 20 months of age before reaching sexual maturity.

From the foregoing analysis it is evident that the specimens born in June-July come to sexual activity during September-October of the following calendar year, that is, when they reach an age of 15 to 16 months. On the other hand, animals born in February-March come to their first sexual activity during September-October of the following calendar year when they are 19 to 20 months of age. This difference in the age for attaining sexual maturity between the two groups of animals born during the two seasons of parturition is due to the fact that when the specimens born in February-March attain an age of 15 to 16 months the breeding season would not have commenced, and hence, they would have to wait another 3 or 4 months to experience their first sexual cycle with the onset of the breeding season during September-October.

Figure 4 is a scatter diagram of the body weight of the male specimens of this species collected on different dates. From this figure it is evident that adult and immature specimens occur throughout the year. Further, after attaining a certain body weight the sexually immature specimens cannot be distinguished from the mature ones on the basis of the body weight. Many immature specimens weigh as much as or even more than mature specimens.

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